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be obvious that some of the Factotums will thus be eminently qualified to "come in place as a lion" at tea-parties, and when necessary to "roar you an 'twere any nightingale."

This, Mr. Editor, is a mere outline of my capacious plan. In an age like the present, when "springes to catch woodcocks" are daily crowded with game, I feel confident that a proposal which embraces objects so philanthropic, and individuals so meritorious, as mine, will not remain unappreciated or unrewarded.

P.

Belfast.

REVIEW OF THE WORKS OF THE LATE RICHARD KIRWAN, ESQ. PRES. R.I.A.—BY JOHN O'REARDON, ESQ. M.D.

(Concluded from last number.)

The first of Mr. Kirwan's essays on meteorology, entitled an "Estimate of the Temperature of different Latitudes," commences with an inquiry into the causes of heat and cold; and with an examination of the influence of the winds, and of evaporation, on the temperature of the atmosphere. The author afterwards combats the opinion of those who suppose that there is a focus of heat in the centre of our globe. We know, however, that some learned geologists still maintain that the central part of the globe forms an immense furnace, or a mass of ignited and melted minerals, which every where struggling for vent, bursts forth wherever there is the least resistance, and produces volcanic eruptions in numerous parts of the world. There are at all events circumstances which induce us to consider it probable, that some very distant volcanos communicate interiorly, or at least alternate in their eruptions with each other.

Mr. Kirwan gives tables of his own construction relative to the mean annual temperature in all latitudes, and accompanies them with judicious remarks. He treats in another chapter of the mean temperature of the months. "Experience," he says, "ascertains that the mean temperature of the month of April nearly constitutes the mean annual temperature, and it is evident, that in as much as the heat may be considered to depend on the influence of the solar rays—the mean temperature of each month should be as the altitude of the sun, or as the sinus of its altitude." The author calculates, according to these principles, the mean heat of the months in each latitude; and at the same time he rectifies his calculations by noticing the influence of the terrestrial heat, which augments the temperature of the last months of summer, and also of the effects of evaporation.

In the third chapter he discusses the differences of the temperatures of the air, earth and water, as likewise their respective capacities for receiving and communicating heat. He observes that with respect to the earth, the matter of heat descends slowly, and is restored to the atmosphere during winter. "It is," says our author, "owing to these causes that at a certain depth from the surface of the earth, as for instance that of 80 or 90 feet, the temperature of the earth varies very little, and in general approaches nearly to the mean annual temperature." Thus the the temperature of fountains differs in no degree from the mean temperature of the air, and it experiences only the slightest variations during the different seasons of the year. The severest cold, provided it be only of some days duration, enters no farther than twenty inches into the interior of the earth in the absence of snow: and it does not penetrate so far as ten inches when the surface of the earth is covered with snow. We therefore see the wise purpose of Providence in furnishing such abundance of snow to the northern latitudes. Mr. Kirwan next proves that the earth exceeds water in its capacity for admitting the heat or cold. It is remarked, that independently of the difference occasioned by certain situations, the earth can admit in summer from eight to ten degrees of heat, and in winter from eight to ten degrees of cold more than the change of temperature that takes place in the sea.

In estimating the effects of the elevations of the different parts of the earth, he says, "when the elevation is inconsiderable, and increases progressively, like the elevation of many countries very remote from the sea, its effects might be confounded with those produced by the distance from the ocean taken as a term of comparison, and they consequently might present the same diminution of temperature." The temperature descends one fourth of a degree, if the elevation be six feet in a mile: it diminishes by one third of a degree, if the elevation consists of seven feet; by four tenths when the elevation amounts to thirteen feet. He gives it as his opinion, that the winters under the antartic zone are less rigorous than under the artic zone, in consequence of the want of terra firma under the first.

The author concludes this work, by renewing his admiration of the wisdom of Omnipotence, which has intersected the surface of our globe with mountains and seas, in such a manner, that though at the first sight all appears irregular, and the result of hazard, and to the eyes of an unreflecting or ignorant spectator the globe presents the aspect only of a heap of immense ruins; yet upon due examination of the effects produced by these seeming irregularities, we become immediately convinced of their being advantageous and salutary for mankind. As respecting the seas, we see that, without noticing the benefit of commerce which could not exist without them, or the immense stock of fish with which they furnish our wants, their neighbourhood tends to moderate the cold of the northern latitudes and the heat of the southern. The mountains are no less necessary than the seas: they not only give origin to rivers, but they serve in many countries as ramparts against the cold blasts, or northern and eastern winds, and in the southern latitudes as screens against excessive heat.

Mr. Kirwan's Essay of 1788, "On the Variations of the Barometer," enters, after some preliminary remarks, on a statement of the principal observations made on the variations of this instrument. First observation:—the deviations of the Mercury from its mean annual altitude are far more frequent and extensive in the vicinity of the poles than in that of the equator. Second observation:—the variations without the tropics are greater and more frequent in the winter than in the summer months. Third observation:—the variations are considerably smaller in very elevated situations than on the level of the sea. Fourth observation:—the mean height of the barometer on the level of the sea, in most parts of the globe hitherto examined, is about 30 inches. But in the proximity of the poles the annual mean heights of the barometer differ much more from this standard than in the most southern parts of our hemisphere. Fifth observation:—in calm weather, when the air is inclined to rain, the barometer is commonly low.

Sixth observation:—upon very high winds, though not accompanied with rain, the barometer sinks lowest, having regard to the quarter from whence the wind blows. Seventh observation:—in serene and settled weather the barometer is generally high; as also in calm and frosty weather. Eighth observation:—the greatest heights of the barometer are found upon easterly and north-easterly winds; to which it may be added, that under a southerly wind it is commonly low. Ninth observation:—the marine barometer never fails to indicate a storm several hours beforehand. But with respect to less considerable changes of weather, it must be allowed that its variations afford no infallible indications—though with certain restrictions they lead to probable conjecture; and the reason of this difference is, because the height of the mercury in the barometer hath no immediate and necessary connexion either with rain or fair weather. That its variable height is the immediate consequence of the variable pressure of the atmosphere, admits of no doubt; but the source of this variable pressure has not yet been fully ascertained.

The causes to which this and its dependent phenomena have been ascribed, are—first, variations of temperature; secondly, the velocity and other qualities of different winds; thirdly, the agency of vapours. Having shown the insufficiency of these causes to which the variable weight of the atmosphere and height of the barometer have been usually referred, the author proceeds to explain that which alone seems to him adequate to the effects produced—namely, the accumulation of air over those parts of the globe in which the mercury exceeds its mean height, that is the height suited to its situation; and the diminution or subtraction of the natural quantity of air over those regions in which the barometer falls beneath its mean height. He calls that the natural state of the atmosphere in which the barometer on the level of the sea would stand at 30 inches in serene weather, conformably to the fourth observation.

The superior tides of air consist chiefly of hydrogen gas, as it is much lighter than any other, and is generated in great plenty between the tropics. It is conjectured that the auroræ borealis and australis proceed from the combustion of this gas through the agency of electricity. The denser air of the North American continent, pressing on the rarer incumbent on the Atlantic, produces the almost constant westerly winds which prevail on the eastern coasts of America, and in the western parts of Europe below lat. 70°, but above that parallel the superior European current passes by a shorter way into America, where the cold is greater, and but merely conjectured.

The descent of the barometer is never the effect of a southerly wind, but both it and this wind are concomitant effects of a rarefaction in the northern parts, proceeding from the passage of the northern air to America, or from frequent and considerable auroræ boreales. On the other hand, the barometer generally rises under a northerly or easterly wind, because the superior atmosphere is accumulated chiefly in those parts of our hemisphere from whence these winds issue; and this accumulated air passess with them to the southern regions. A certain proof that this accumulation is the true cause of their superior density is, that when this northerly wind is surmounted by a south-west wind, the barometer falls, as the southerly winds in the superior regions are attended with a rarefaction in the superior or northern tracts.

We must in like manner keep in mind, that though clouds and a disposition to rain frequently follow the descent of the barometer, yet this descent is not the immediate consequence of either clouds or rain; on the contrary, the barometer frequently rises during the rain. But the rarefaction of the atmosphere, which produces the descent of the barometer, and which arises from the removal of the superior accumulation, is favourable to the production of clouds; as a heavy atmosphere, though it supports vapours once formed, obstructs evaporation. When, therefore, its weight is diminished, and evaporation is increased, it soon becomes saturated in the higher regions, and clouds are formed. But rain seems to arise from a subtraction of the electrical fluid, which, when the air abounds with vapours, is easily conducted to the earth.

In serene and settled weather the barometer is generally high, because the greatest disturbances of the atmosphere are connected with its rarefied state, which is commonly pretty distant when the superior accumulation is considerable. In spring the current of superior air begins to flow to the south, and in autumn to return from it;—hence, the equinoctial storms, and frequent variations of the barometer in those seasons.

Mr. Kirwan's third meteorological essay, that of 1801, "On the Variations of the Atmosphere," treats successively of evaporation—and of the influence of heat, affinity, wind, electricity, and light, on evaporation; of the state of vapours subsisting in the atmosphere; of the temperature of the atmosphere in the summer and winter months; of the origin of the general trade winds; of variable winds; of the variations of the temperature of the summer and winter seasons that occur in different years; of the temperature of the southern hemisphere; of the density of the atmosphere; of precipitations from the atmosphere—such as atmospherical electricity, dew, rain, and the haze of the year 1783; of prognostics regarding the weather, according to the tests afforded by the barometer and hygrometer; of hygrometrical tables; from which treatise the following observations are selected:

Vapours arise more copiously and readily in rarefied air than in air of greater density, if the temperature of both sorts of air be equal. A diminution of the density of the atmosphere amounting to one third, everything else being equal, doubles the quantity of evaporation. Moist air, like many other alloys, is specifically lighter than dry air. Air receiving vapours acquires a still greater addition to its volume than it does to its weight; besides, vapour is lighter than air.

Concentrated solutions of most salts evaporate much more slowly than pure water, in the same circumstances: but it is ascertained that the evaporation from a solution of common salt, whose specific gravity is 1.0466, and consequently containing 16 per cent., is nearly equal to that of simple water. Hence we see that under equal surfaces, evaporation from the sea is as considerable as that from lakes.

Ice evaporates more during congelation than when its congelation is completed; and ice and water evaporate more than mere water of the same temperature.

Our northerly and easterly winds, though some degrees colder than the southerly and westerly, yet favour evaporation much more, the air conveyed by them being farther from saturation.

It appears by Mr. Kirwan's experiments, made in July, August, and September, 1783, that when the temperature of the air is from 75° to 80°; and during a calm, the cold occasioned in water by evaporation, during five minutes, is from 8° to 12°—even though the rays of the sun be intercepted: secondly, that during the gentler breeze from the south the cold is diminished—but if from the north or east, it is increased: and thirdly, that where the temperature is from 65° to 75°, the cold produced is from 3° to 5°. According to other experiments made by our author, on the cold produced in air by the evaporation of liquids in contact with it, (for instance, by that from wet sheets wrung and extended vertically in a room,) it is shown that the solution of 3·6 grains in a cubic foot of air in sixteen minutes, cools it one degree. If the saturability of air were greater, it would undoubtedly cool it more, and in a shorter time.

Mr. Kirwan mentions, upon Dr. Black's authority, that the vapour of water boiling at 212° that is 180° above the freezing point, and possessing the same sensible heat as the water, contains nine hundred and forty times more latent heat than an equal weight of water does heated to 212° or 5·222 times more latent heat than it does of sensible heat, counting from the freezing point.

As air is cooled by the reception of moisture dissolved in it, we must infer that its capacity for containing heat is increased; and hence moist air is more difficult to be heated or cooled than dry air of the same temperature: for the cold proceeds from the absorption and not from the expulsion of caloric.

As vapours unite to air partly through the agency of heat, and partly through that of affinity and of electricity, so they separate from it, sometimes from a diminution of that degree of heat which they possessed in their nascent state, sometimes from a diminution of affinity, and sometimes from an alteration in their electrical state. Vapours issuing from water, or moisture warmer than the air to which they unite, are soon cooled by it, and are thence in a great measure dismissed. On this principle are to be explained the morning mists observed in summer, and the winter mists of the colder regions. Evening mists, on the other hand, proceed from the super-saturation of air with vapours previously dissolved, arising from the supervening decreased temperature. The author enters into a pleasing and rational theory, relative to the formation of clouds by the coalescence of vapours, to follow which would require more space than can be here allotted to it. In the warmer latitudes and seasons, various strata of clouds may be formed one above the other. The clouds which commonly crown the summits even of low mountains, and often announce rain, are caused by the near approach to saturation at those elevations, and its actual attainment through the evaporation from those summits. But the tops of the loftiest mountains, ever crowned with snow, are generally shrouded in clouds, from the cold they impart to the air in contact with them, and the loss of electricity conducted away by the mountains from the vapours contained in that air.

The heights at which the lowest clouds are formed, are different in different latitudes and seasons; greater in the warmer and smaller in the colder.

The heat of the atmosphere is derived not from the immediate action of the solar rays that traverse it, but from the warmer and more solid bodies with which it is or has been in contact.

During the winter months the temperature of the higher strata of the atmosphere is often warmer than that of the lower.

Barometers, in the northern parts of Europe at least, generally stand highest in the months of December, January, and February.

It is well known that the smallest variations of the barometer occur within the tropics, but that they gradually increase as we recede from them.

It is a fact with which the above and other phenomena seem to be connected, that the equatorial air, and that of the tropic to which the sun approaches, being rarefied by heat and pressed upon by the colder air, rises and diffuses itself above, forming a current in a contrary direction to the subjacent inferior current of the colder air.

With respect to winds, one general and fundamental principle, according to our author, is, that they always originate at the extremity of that point towards which they proceed. In the western parts of our continent and hemisphere northerly winds are, of all others, the least frequent in latitudes above 48 °. But in latitudes below 48° they occur oftener, and oftenest in those that are still lower: an admirable contrivance of Divine Providence, that the warmest winds should prevail oftenest in winter in the coldest regions, and cold winds in the warmest! it has been often observed, but is particularly well proved since the invention of balloons, that currents of air from different and even opposite points of the horizon prevail at different heights in the atmosphere, over the same tracts of land and water.

Snow falling from some height, is generally, for some time, surrounded with an atmosphere much colder than the air some feet above it. But when there is not a recent fall of snow, the air several feet above the surface of the earth is generally colder (when no great evaporation takes place) than that nearer to its surface.

Mere atmospheric air is an ideo-electric, or non-conducting substance. Mere vapour is a conductor of electricity, and so much the more perfect as it is hotter; it moreover contains and appropriates a considerable portion of the electric fluid.

Dew is nothing more than the condensed vapours elevated during the day from the soil over which the air that deposits it is incumbent; and hence its noxious qualities when elevated from stagnating marshes, and the various impregnations it has been found to contain.

Rain is the immediate result of the union of the particles which form clouds: and this union proceeds from the subtraction of the electric atmospheres which keep them at a distance from each other; and this subtraction is itself the consequence either of the superior attraction of better conductors, or of the attraction or repulsion of other clouds. A more satisfactory explanation of the cause of rain will be submitted farther on.

Southerly winds are most frequently accompanied with rain, in most parts of Europe at least, and probably in most parts of our hemisphere; but northerly and easterly, with clear, dry and serene weather. Since southerly winds are not only warmer, proceeding from warmer climates, but also more highly electrified than the soil of the colder countries into which they flow. North-easterly and easterly winds on the contrary, proceeding from colder countries, are less highly electrified than the soil of the countries they invade; upon which account they introduce serene weather and a disposition adverse to nubification.

A tendency to rain is generally connected with a diminution of the weight of the atmosphere, as is a tendency to serenity with the increase of its weight. Because under the diminished weight of the atmosphere, the eruption of vapours both by land and water is much more capacious, a circumstance highly favourable to nubification.

It rains much more on the western coasts of most regions of Europe, particularly if mountainous, than in the interior parts of the same countries, or on the eastern coasts of the Britannic Islands, of which the cause is obvious: the westerly winds, by far the most frequent in most parts of Europe, flow from the Atlantic, which bounds it, and generally conveys marine clouds electrified differently from the soil or land over which they pass, as also from the higher clouds under which they lie; hence proceeds their mutual attraction—and thence rain. This effect must take place principally on the western coasts: when they proceed further, this different electrical state must either cease or be diminished. When the coasts are mountainous, they quickly absorb the electric matter contained in the western blasts, and by collision, condense the vapours they contain, first into clouds, and finally into rain.

It often happens that westerly winds, particularly in summer, produce no rain, either because they introduce no clouds, or meet with none differently electrified. It scarcely ever rains on the plains of Peru, extending from near the equator to within half a degree of the tropic of Capricorn, or on the deserts of Arabia and Africa, and in Upper Egypt, situated under the tropic of Cancer, in consequence of local circumstances, such as the sandy nature of considerable portions of these regions, and the electrical agency of bordering mountains.

The foregoing three essays taken together, may, notwithstanding a few errors, be well said to constitute a truly instructive meteorological treatise, which merits a place in company with the works of Deluc, De Saussure, and the more modern writings of Hutton, Dalton, and Leslie. In consequence of the researches of modern philosophers, and the improvements made by some of them in the thermometer, barometer, and hygrometer, we now have more distinct ideas on many points of meteorology, and particularly relative to the phenomena of aqueous meteors, viz. rain, fog, dew, &c. It appears that there is an aqueous vapour atmosphere distinct from, and at the same time combined with the general atmosphere. It is subject to the same laws as the atmosphere at large; that is, it must decrease in density in ascending in a geometrical progression to increments of height in arithmetical progression, or at least it must be constantly tending to that state. Heat promotes evaporation, and contributes to retain the vapour when in the atmosphere, and cold precipitates or condenses the vapour. But rain is as frequently attended with an increase as with a diminution of the temperature of the atmosphere. The solvent power of the air being higher than what is proportionate to the increase of temperature, the quantity of vapour capable of entering into the air increases in a greater ratio than the temperature. The precipitation of vapour in the form of clouds and rain is occasioned not by mere cold, but a mixture of comparatively warm and cold air; so whenever two masses of air of different temperatures are by the ordinary currents of the winds intermixed, each being previously saturated with vapour, a precipitation ensues in consequence of the mean temperature not being able to support the mean quantity of the vapour. If the masses be under the point of saturation, then less precipitation takes place, or none at all, according to the degree. Also, the warmer the air, the greater is the quantity of vapour precipitated in like circumstances. Hence the reason why rains are heavier in summer than in winter, and in warm countries than in cold.

J. O'R.